

## CLAIMS

What is claimed is:

1. An integrated circuit (IC) package comprising:  
a package body;  
5 an IC die positioned within the package body;  
a lead frame including a plurality of leads having portions enclosed within the package  
body that connect to the IC die; and  
an electrically conductive heat sink positioned at least partially within the package body  
with a surface of a first portion of the heat sink facing the lead frame in close  
10 proximity to a substantial part of the enclosed portion of each of the leads of the  
lead frame and with a die-attach area on the surface of the first portion attached to  
the IC die, a second portion of the heat sink projecting away from the first portion  
under the die-attach area and the IC die.

2. The IC package of claim 1, wherein the package body is selected from a  
group comprising a transfer molded plastic package body and a preformed ceramic  
package body.

3. The IC package of claim 1, wherein the IC die is selected from a group  
comprising a Dynamic Random Access Memory (DRAM) IC die, a Static Random Access  
Memory (SRAM) IC die, a Synchronous DRAM (SDRAM) IC die, a Sequential Graphics  
Random Access Memory (SGRAM) IC die, a flash Electrically Erasable Programmable  
Read-Only Memory (EEPROM) IC die, and a processor IC die.

4. The IC package of claim 1, wherein the lead frame is selected from a group  
comprising a peripheral-lead finger lead frame, a Leads Over Chip (LOC) lead frame, and  
a Leads Under Chip (LUC) lead frame.

5. The IC package of claim 1, wherein the heat sink is coupled to one of a signal voltage and a reference voltage so the heat sink operates respectively as a signal plane and a ground plane for the leads of the lead frame.

6. The IC package of claim 5, wherein the heat sink is coupled to the reference voltage through one of a wirebond, a conductive adhesive, and a welded connection.

7. The IC package of claim 1, wherein the heat sink is electrically isolated from the lead frame.

8. The IC package of claim 1, wherein the heat sink is positioned only partially within the package body.

9. The IC package of claim 1, wherein the heat sink is coupled to a printed circuit board outside the package body and is thereby coupled to one of a signal voltage and a reference voltage so the heat sink operates respectively as a signal plane and a ground plane for the leads of the lead frame.

10. The IC package of claim 8, wherein the second portion of the heat sink projects substantially to one of a top and a bottom of the package body.

11. The IC package of claim 1, wherein the heat sink is positioned within the package body with the surface of its first portion in close proximity to substantially all of the enclosed portion of each of the leads of the lead frame.

12. The IC package of claim 1, wherein the heat sink is positioned within the package body with its first portion extending substantially to at least one side of the package body.

13. The IC package of claim 1, wherein the heat sink is positioned within the package body with the surface of its first portion in close proximity to at least eighty percent of an area of the enclosed portion of the lead frame.

14. The IC package of claim 1, wherein the first and second portions of the heat sink are integral with one another.

15. The IC package of claim 1, wherein the first and second portions of the heat sink comprise separate parts.

16. The IC package of claim 1, wherein the heat sink comprises a plurality of parts, each forming a portion of both the first and second portions of the heat sink.

17. The IC package of claim 1, wherein the surface of the first portion of the heat sink includes a recess in which the die-attach area is located.

18. The IC package of claim 1, wherein the heat sink has locking holes therein for locking the heat sink in the IC package.

19. The IC package of claim 1, further comprising an adhesive attaching the lead frame to the heat sink.

20. The IC package of claim 1, wherein the IC package comprises one of a Vertical Surface Mount Package (VSMP), a Small Outline J-lead (SOJ) package, a Thin Small Outline Package (TSOP), a Quad Flat Pack (QFP), and a Thin QFP (TQFP).

21. A heat sink for an integrated circuit (IC) package having a lead frame including a plurality of leads having portions enclosed within the IC package that connect to an IC die, the heat sink comprising:

a first portion having a surface constructed to face the lead frame in close proximity to a substantial part of the enclosed portion of each of the leads of the lead frame, a die-attach area on the surface of the first portion being attachable to the IC die; and

5 a second portion substantially opposite the die-attach area for projecting away from the first portion under the die-attach area and the IC die.

22. An electronic system comprising an input device, an output device, a memory device, and a processor device coupled to the input, output, and memory devices, at least one of the input, output, memory, and processor devices including an integrated circuit (IC) package comprising:

10 a package body;

an IC die positioned within the package body;

15 a lead frame including a plurality of leads having portions enclosed within the package body that connect to the IC die; and

an electrically conductive heat sink positioned at least partially within the package body with a surface of a first portion of the heat sink facing the lead frame in close proximity to a substantial part of the enclosed portion of each of the leads of the lead frame and having a die-attach area on the surface of the first portion attached to the IC die, a second portion of the heat sink being opposite the die-attach area and projecting away from the first portion and the IC die.

23. A lead frame assembly comprising:

a lead frame; and

25 a heat sink positioned with a surface in a substantially mutually parallel and co-extensive relationship with, and in close but electrically insulated proximity to, the lead frame.

24. An integrated circuit (IC) package comprising:  
a package body;  
an IC die positioned within the package body;  
a lead frame including a plurality of leads having portions enclosed within the package  
5 body that connect to the IC die; and  
an electrically conductive heat sink positioned at least partially within the package body  
with a vertically extending columnar portion surrounded by a horizontally  
extending skirt portion having a lead frame attachment surface proximate a die-  
attach surface substantially vertically aligned with the columnar portion, the lead  
10 frame attachment surface being attached to the lead frame and extending in close  
proximity to a substantial part of the enclosed portions of the leads of the lead  
frame, the die-attach surface being attached to the IC die.

25. An integrated circuit (IC) package comprising:  
15 an IC die;  
a lead frame including a plurality of leads having portions that are connected to the IC die;  
and  
an electrically conductive heat sink positioned having a surface of a first portion of the  
heat sink facing the lead frame in close proximity to a substantial part of the  
20 enclosed portion of each of the leads of the lead frame and with a die-attach area  
on the surface of the first portion attached to the IC die, a second portion of the  
heat sink projecting away from the first portion under the die-attach area and the  
IC die.

26. The IC package of claim 25, further comprising:  
25 a package body.

27. The IC package of claim 26, wherein the package body is selected from a group comprising a transfer molded plastic package body and a preformed ceramic package body.

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Sub B9  
28. The IC package of claim 25, wherein the IC die is selected from a group comprising a Dynamic Random Access Memory (DRAM) IC die, a Static Random Access Memory (SRAM) IC die, a Synchronous DRAM (SDRAM) IC die, a Sequential Graphics Random Access Memory (SGRAM) IC die, a flash Electrically Erasable Programmable Read-Only Memory (EEPROM) IC die, and a processor IC die.

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29. The IC package of claim 25, wherein the lead frame is selected from a group comprising a peripheral-lead finger lead frame, a Leads Over Chip (LOC) lead frame, and a Leads Under Chip (LUC) lead frame.

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30. The IC package of claim 25, wherein the heat sink is coupled to one of a signal voltage and a reference voltage so the heat sink operates respectively as a signal plane and a ground plane for the leads of the lead frame.

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Sub B10  
31. The IC package of claim 30, wherein the heat sink is coupled to the reference voltage through one of a wirebond, a conductive adhesive, and a welded connection.

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Sub C3  
32. The IC package of claim 25, wherein the heat sink is electrically isolated from the lead frame.

33. The IC package of claim 26, wherein the heat sink is positioned only partially within the package body.

34. The IC package of claim 26, wherein the heat sink is coupled to a printed circuit board outside the package body and is thereby coupled to one of a signal voltage and a reference voltage so the heat sink operates respectively as a signal plane and a ground plane for the leads of the lead frame.

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Sub A9b  
Sub C3  
35. The IC package of claim 34, wherein the second portion of the heat sink projects substantially to one of a top and a bottom of the package body.

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36. The IC package of claim 26, wherein the heat sink is positioned within the package body with the surface of its first portion in close proximity to substantially all of the enclosed portion of each of the leads of the lead frame.

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Sub A9b  
Sub C3  
37. The IC package of claim 26, wherein the heat sink is positioned within the package body with its first portion extending substantially to at least one side of the package body.

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38. The IC package of claim 26, wherein the heat sink is positioned within the package body with the surface of its first portion in close proximity to at least eighty percent of an area of the lead frame.

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39. The IC package of claim 25, wherein the first and second portions of the heat sink are integral with one another.

40. The IC package of claim 25, wherein the first and second portions of the heat sink comprise separate parts.

41. The IC package of claim 25, wherein the heat sink comprises a plurality of parts, each forming a portion of both the first and second portions of the heat sink.

SUB  
C3  
cancel.  
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42. The IC package of claim 25, wherein the surface of the first portion of the heat sink includes a recess in which the die-attach area is located.

43. The IC package of claim 25, wherein the heat sink has locking holes therein for locking the heat sink in the IC package.

44. The IC package of claim 25, further comprising an adhesive attaching the lead frame to the heat sink.

10 45. The IC package of claim 25, wherein the IC package comprises one of a Vertical Surface Mount Package (VSMP), a Small Outline J-lead (SOJ) package, a Thin Small Outline Package (TSOP), a Quad Flat Pack (QFP), and a Thin QFP (TQFP).